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DARLINGTON NGS COMMISSIONING AQUATIC STUDIES GILL NETTING - 1989

Report No 91-86-K

R.W. Sheehan - Biologist
Biological Research Section
Chemical Research Department

ABSTRACT

The results of the 1989 Darlington NGS gill netting study are presented. Eighteen fish species were present in the 6,722 fish collected. Alewife was the dominant fish species comprising 89.3% of the total catch. Lake trout and round whitefish were the other major species. The percentage composition of alewife was similar in the preoperational and 1989 studies. Lake trout percentage composition increased in the 1989 study while round whitefish percentage composition decreased. The distribution of fish species was generally similar during both study phases. The majority of dominant fish species were collected at the inshore end of the diffuser. Greater numbers of fish and fish species were collected in the bottom net sets.

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34-149-492	837.321 DAR	August 7, 1991	91-86-K

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DARLINGTON NGS COMMISSIONING
AQUATIC STUDIES GILL NETTING - 1989

Report No 91-86-K

R.W. Sheehan - Biologist
Biological Research Section
Chemical Research Department

EXECUTIVE SUMMARY

The results of the first year of the 1989 Darlington NGS commissioning gill netting study are presented. The commissioning gill netting studies were a continuation of the Darlington NGS environmental monitoring program. Preoperational gill netting studies were conducted previously from 1984 to 1988 (OHRD Reports 87-822-K and 90-54-K). Biological Research Section, Research Division, conducted the 1989 commissioning study at the request of Environmental Studies and Assessments Department of Design and Development Division - Generation.

A total of 6,722 fish constituting 18 fish species were collected in the 8 netting periods. Alewife continued to be the dominant fish species comprising 89.3% of the total catch. Lake trout (5.5 %), round whitefish (1.6%) and white sucker (1.0%) were the other major species.

Alewife catches were similar in late May and early July. Peak alewife abundance occurred in late July after which it declined substantially.

Lake trout was the dominant salmonid species collected. Lake trout abundance peaked in early October with reduced catches in early July and late October. Higher water temperatures may have contributed to the lower late October catches. Brown trout and rainbow trout occurred in low numbers while the occurrence of chinook and coho salmon was minor.

Round whitefish abundance increased generally through the study period, reaching peak abundance in late November.

Alewife, lake trout and round whitefish abundances were highest at the inshore end of the diffuser (site A). Alewife abundance peaked at this location in July, while lake trout and round whitefish were present at site A primarily in the fall.

The percentage composition of alewife was similar in the preoperational and 1989 commissioning phases. The 1989 lake trout percentage composition however, was higher than the mean preoperational phase percentage composition. Round whitefish percentage composition decreased in the commissioning phase. Seasonal distribution of these species was generally similar between study phases.

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34-149-492	837.321 DAR	August 7, 1991	91-86-K

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DARLINGTON NGS COMMISSIONING
AQUATIC STUDIES GILL NETTING - 1989

1. INTRODUCTION

Darlington Nuclear Generating Station, located 64 km east of Toronto on the north shore of Lake Ontario, has been under construction since 1977. Preoperational aquatic studies were conducted at the Darlington site from 1984 to 1988 as part of the environmental monitoring program. The first year of commissioning studies followed the preoperational phase in 1989. The results of the commissioning gill net study are presented in this report. Biological Research Section, Research Division, performed the gill netting studies at the request of Environmental Studies and Assessments Department of Design and Development Division - Generation.

The Darlington NGS commissioning studies were designed to provide the data base linking preoperational and postoperational studies. The gill netting study data will provide information on species composition and relative abundance, with emphasis on the cold water species. These data will assist in the determination of any effects of station operation on the fisheries community within the vicinity of the Darlington NGS. The present study was conducted while the station was discharging unheated service water through the diffuser.

2. METHODS

Sampling methods were similar to the methodologies employed in the preoperational studies (OHRD Reports 87-822-K and 90-54-K). Four locations (A, D, F and H, Figure 2.0-1) were sampled in 1989. Locations A (8 m depth) and D (11 m depth) were situated near the inshore and offshore ends of the 900 m diffuser, respectively. Locations F and H were reference sampling areas located west and east of the station respectively, along the 10 m depth contour.

The fish populations at each of the sampling sites were sampled with gill nets. Each net consisted of 8 experimental panels (15.2 m long x 1.5 m deep) constructed of white multifilament nylon. Mesh sizes (stretched measure) ranged from 3.8 cm to 12.5 cm in increasing 1.3 cm increments. All nets were fished with the smallest panel inshore. Bottom and surface nets were fished on consecutive days at each location for a 24 h period, lake and weather conditions permitting.

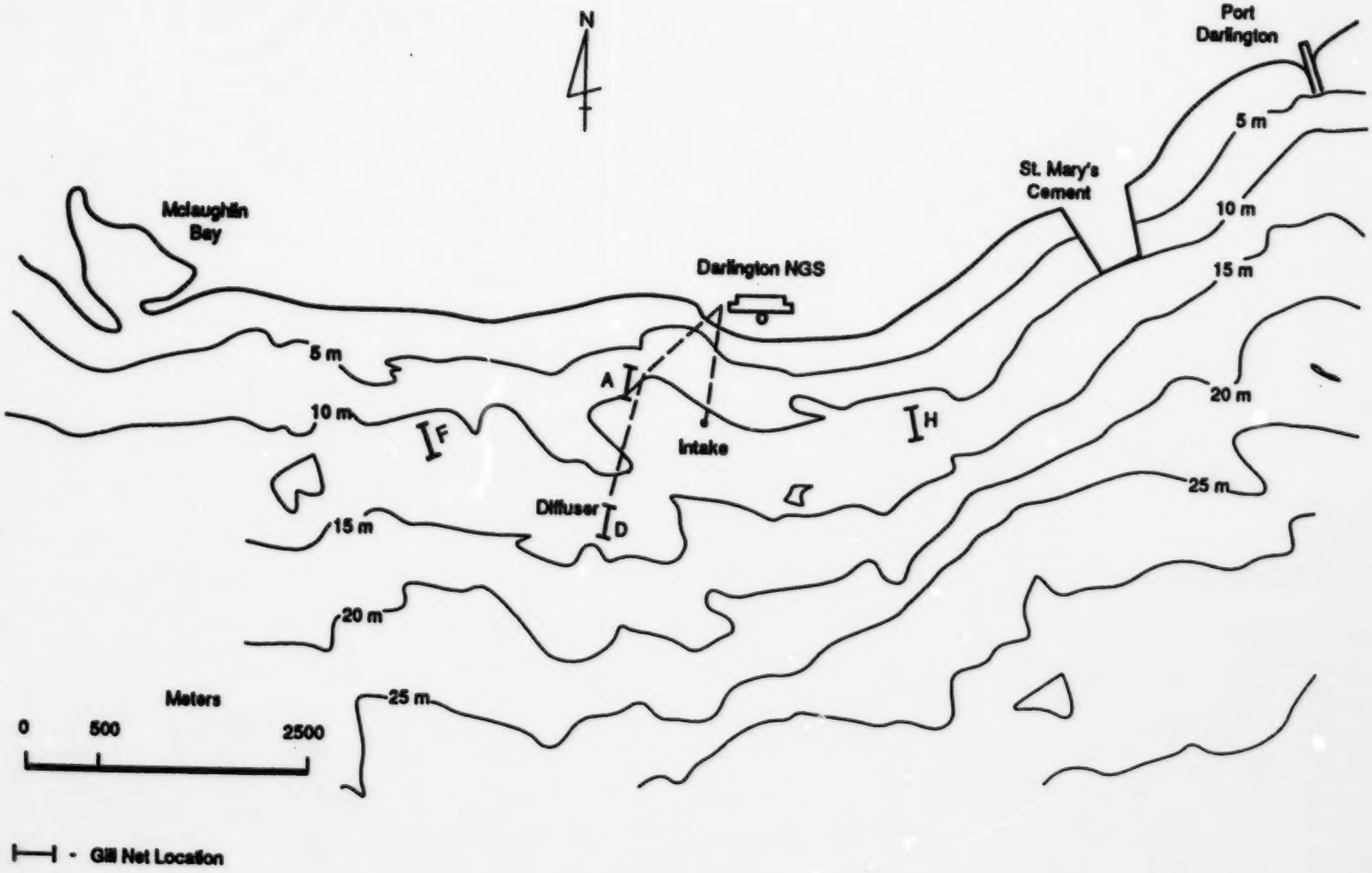

FIGURE 2.0-1

DARLINGTON GILL NET STUDIES
SITE MAP

Sampling was conducted twice in the months of May, July, October and November. Weather and lake conditions prohibited scheduled sampling in December. The within-month sampling periods were separated by a minimum of one week to permit investigation of weekly catch variability. Water temperatures were recorded at the time of net set and retrieval.

All fish collected, except for redhorse sucker, were identified to species and enumerated. Meristic data (fork length and weight), scales and sexual maturity data were collected from all salmonids and coregonids whenever possible. All salmonids and coregonids were also observed for external marks, tags and parasites. All viable fish were released.

3. RESULTS

The catch results and species composition list of the 1989 Darlington gill net study are presented in Appendices A and B, respectively. The water temperatures recorded with the setting and retrieval of each net are reported in Appendix C.

The 8 netting periods produced 6,722 fish constituting 18 fish species. Alewife was the dominant species comprising 89.3% of the total fish catch (Table 3.0-1). Lake trout (5.5%), round whitefish (1.6 %) and white sucker (1.0%) were the other major species.

The same species were dominant in the bottom nets (Table 3.0-1). Alewife composition was slightly lower than in the total catch; however lake trout, round whitefish and white sucker numbers were slightly greater. Alewife and lake trout were the dominant species present in the surface nets as well; however rainbow trout and brown trout were the other major surface net species.

Alewife were most prevalent in the late July sampling period (Figure 3.0-1). Lower similar catches occurred in the late May and early July sampling periods. Alewife abundance declined substantially following the peak late July catches. The seasonal variation in alewife catches was significant (Appendix D).

Table 3.0-1

Dominant Fish Species Darlington NGS 1989

SURFACE NETS

SPECIES	%
Alewife	92.8
Lake Trout	3.8
Rainbow Trout	1.4
Brown Trout	1.4

BOTTOM NETS

SPECIES	%
Alewife	87.4
Lake Trout	6.4
Round Whitefish	2.5
White Sucker	1.5

COMBINED NETS

SPECIES	%
Alewife	89.3
Lake Trout	5.5
Round Whitefish	1.6
White Sucker	1.0

Lake trout was the dominant salmonid species collected in the 1989 study (Figure 3.0-2). They were collected in all sampling periods and peaked in abundance in early October. Lower catches occurred in the early July and late October sampling periods. High water temperatures (range 10.7 - 12.0°C, Appendix C) may have contributed to the reduced late October lake trout catches. The seasonal variation in lake trout catches was determined to be significant (Appendix D).

Brown trout and rainbow trout occurred in low numbers (Figure 3.0-2). Brown trout were collected primarily from late July through late October while rainbow trout were present primarily in October. The occurrence of chinook and coho salmon was minimal. Fewer than 10 fish of each of these species were collected in the 1989 study.

Round whitefish abundance increased from May to October (Figure 3.0-3). Whitefish catches then declined in early November before attaining peak abundance in late November. The seasonal variation in round whitefish catches was significant (Appendix D).

White sucker abundance increased generally from May to early October (Figure 3.0-3). The catch then declined through the November sampling periods.

Alewife abundance was greatest at the diffuser sampling sites with peak numbers occurring at the inshore location A (Figure 3.0-4). Alewife abundance was lowest at control site F. The differences in alewife catch at sampling locations was not significant (Appendix D). Peak numbers were collected at all sampling sites in late July. The catches declined sharply at each location following peak abundance.

Lake trout were present primarily at diffuser location A (n = 169 total fish) and the east control location H (n = 117 total fish, Figure 3.0-5). Peak numbers were collected during the early October sampling period at all sampling locations. Equal numbers of lake trout were caught at locations A and H (n = 48 fish per session) at this time. The catches then decreased sharply in late October with maximum numbers of lake trout collected at the offshore diffuser location D (n = 17 fish per session). The variation in lake trout catches at the sampling locations was not significant (Appendix D).

The maximum numbers of round whitefish were collected at location A (n = 41 total fish, Figure 3.0-6). The total catches at the remaining sampling locations ranged from 28 fish (location F) to 16 fish (location D). The round whitefish population peaked at most sampling locations in late November. Maximum numbers of fish were collected at sampling location A at this time (n = 18 fish). This catch was more than double the catch at any of the other sampling locations. The variation in round whitefish catches at the sampling locations was not significant (Appendix D).

The majority of the 6,722 fish collected in the 1989 study (n = 4,332 fish) were present in the bottom nets. Slightly more than one third of the fish collected were present in the surface nets (n = 2,390 fish). The differences in surface and bottom net catches were not significant (Appendix D).

Ten fish species were collected in the surface nets while 17 species were collected in the bottom nets. Coho salmon (n = 1) was present only in the surface nets. Round whitefish (n = 106), lake whitefish (n = 1), lake chub (n = 19), white perch (n = 11), yellow perch (n = 2), walleye (n = 3), brown bullhead (n = 9) and carp (n = 1) were collected only in the bottom nets.

4. DISCUSSION

The 1989 study catches were lower than the average preoperational study catches (Figure 4.0-1). Alewife continued to be the dominant species collected at Darlington NGS. The average percentage composition of preoperational study alewife was 89.7%. This percentage was comparable to the 89.3 % composition recorded during the 1989 study. The differences between the average alewife catch during the preoperational study years and the 1989 study were not significantly different (Appendix D).

GILL NET CATCH
OF ALEWIFE AND ALL SPECIES,
DARLINGTON, 1989

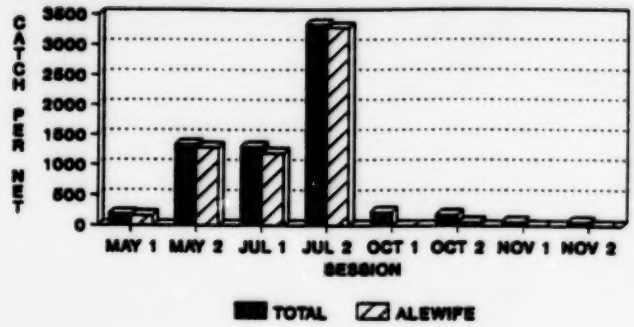

FIGURE 3.0-1

SALMONID GILL NET CATCH
DARLINGTON, 1989

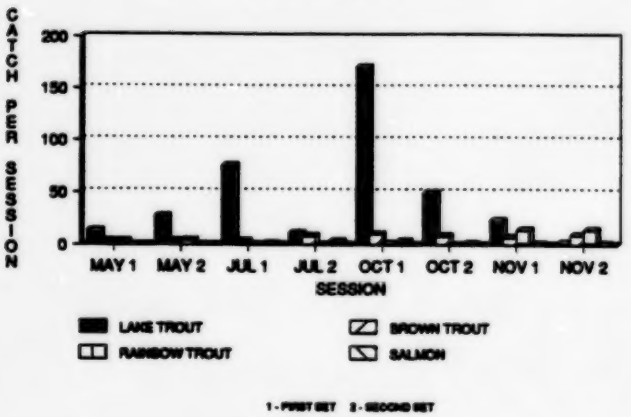

FIGURE 3.0-2

ROUND WHITEFISH AND WHITE SUCKER
BOTTOM GILL NET CATCH
DARLINGTON, 1989

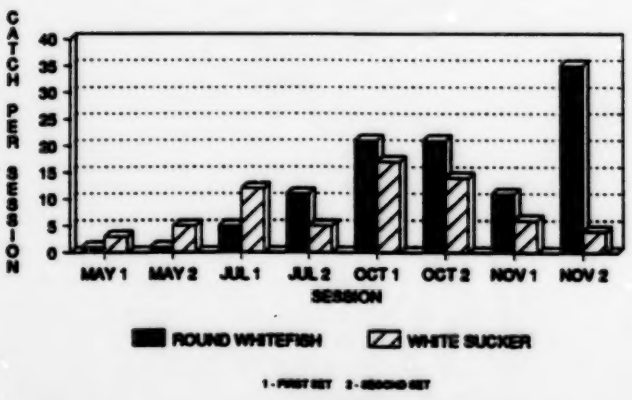

FIGURE 3.0-3

ALEWIFE GILL NET CATCH
BY LOCATION
DARLINGTON, 1989

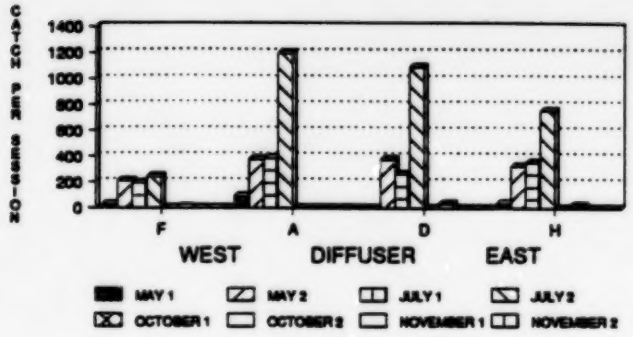

FIGURE 3.0-4

LAKE TROUT GILL NET CATCH
BY LOCATION
DARLINGTON, 1989

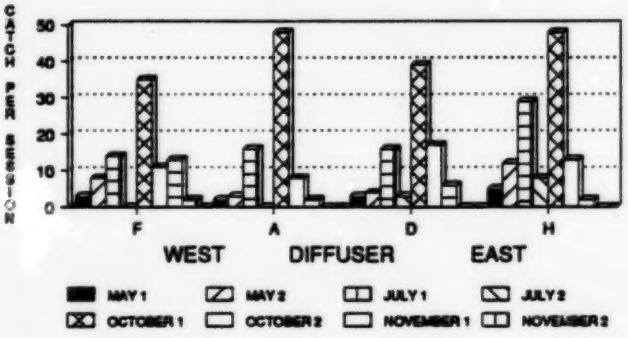

FIGURE 3.0-5

SEASONAL ROUND WHITEFISH
CATCH BY LOCATION
DARLINGTON, 1989

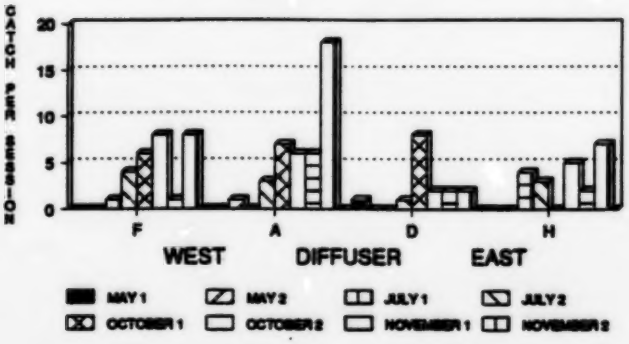

FIGURE 3.0-6

The 1989 study lake trout percentage composition (5.5%, n = 5.8 fish per net) exceeded the average 2.3% preoperational study percentage composition (n = 3.7 fish per net, Figure 4.0-1). It also exceeded the highest yearly preoperational percentage composition (3.5%) recorded in 1986. However, a greater number of lake trout were collected in 1986 (n = 6.4 fish per net) than in 1989 (n = 5.8 fish per net). The variation between the average lake trout catch during the preoperational study years and the 1989 study was significant (Appendix D). The percentage compositions of round whitefish and white sucker were lower in the 1989 study than in the preoperational study.

Seven fish species collected during the preoperational study were absent in the 1989 study catches (Table 4.0-1). None of these species was abundant in the preoperational studies nor were they collected during every sampling year. No new species were collected in the 1989 study.

Table 4.0-1

Species Absent in Commissioning Study Darlington NGS, 1989

Fish Species	Number Collected 1984 to 1988	Probability of Occurrence in Preoperational Study
Longnose gar	2	40%
Longnose sucker	1	20%
Redhorse suckers	6	80%
Rock bass	10	60%
Smallmouth bass	2	20%
Freshwater drum	5	60%
Sculpin	2	40%

The average alewife catches during the preoperational study were similar at each of the sampling locations (Figure 4.0-2). The 1989 study catches were greatest at location A. Catches at the remaining sampling locations declined to very low catches at location F. The average preoperational study catches exceeded the 1989 study catches at all sites.

The 1989 alewife seasonal distribution followed the preoperational study trend. The number of alewife increased through May peaking in abundance in July. Substantially lower alewife catches followed in October and November.

The preoperational study average catch of lake trout was exceeded by the 1989 study lake trout catch (Figure 4.0-3). Maximum numbers were collected at locations A and H during both studies with similar numbers collected at the remaining locations.

The seasonal distribution of lake trout in the 1989 study followed the preoperational study distribution trend. Lake trout abundance increased to an October peak followed by a rapid November decline.

Round whitefish were more numerous during the preoperational study than in the 1989 study (Figure 4.0-4). Similar high average catches were determined at locations F and A during the preoperational study. The 1989 study catches were greatest at location A with lower numbers at location F.

Round whitefish seasonal abundance was similar in both preoperational and 1989 studies. Round whitefish numbers increased generally from May to November. Peak abundance occurred in December in the

AVERAGE DOMINANT SPECIES CATCH
DARLINGTON 1984 -- 1989

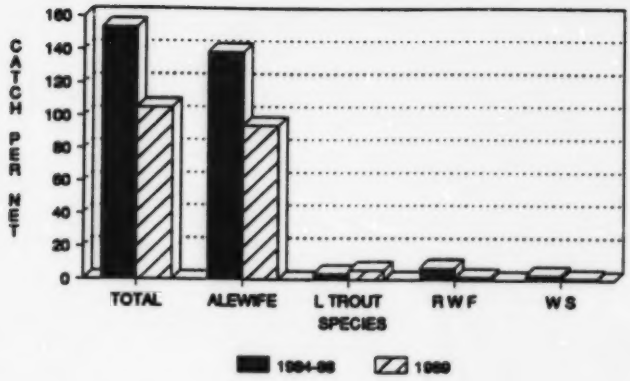

FIGURE 4.0-1

AVERAGE ALEWIFE CATCH
BY LOCATION
DARLINGTON 1984 -- 1989

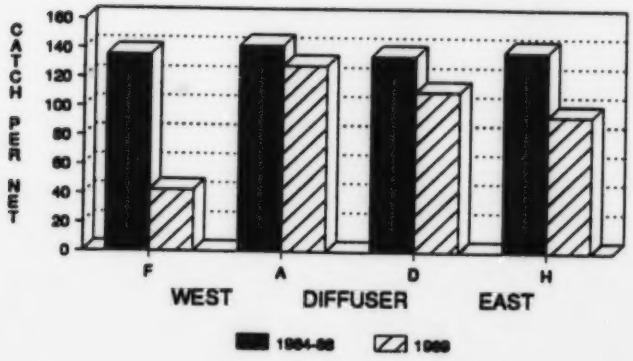

FIGURE 4.0-2

AVERAGE LAKE TROUT CATCH
BY LOCATION
DARLINGTON, 1984 -- 1989

FIGURE 4.0-3

AVERAGE ROUND WHITEFISH CATCH
BY LOCATION
DARLINGTON 1984 -- 1989

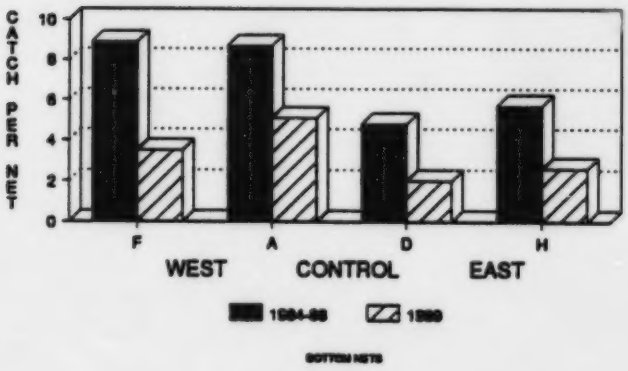

FIGURE 4.0-4

preoperational study. No December data were available for the 1989 study.

The greatest numbers of fish and fish species continued to be collected in the bottom nets. Bottom nets collected 67.4% of the total preoperational study catch and 64.4% of the 1989 study catch. The variation in surface and bottom net catches was significant in the preoperational study. However, no significant variation was apparent in the 1989 surface and bottom catches (Appendix D).

Twenty-four of the 25 fish species collected in the preoperational study were present in the bottom nets. Similarly, 17 of the 18 fish species collected in 1989 were present in the bottom nets. Nineteen and 10 fish species were collected in the preoperational and 1989 studies surface nets, respectively.

Hypotheses of effect were developed at Darlington NGS workshops. Participants from the Ontario Ministries of Environment and Natural Resources, the federal Department of the Environment and Ontario Hydro attended the workshops (Greig et al, 1984). Hypothesis No. 7 concerns the effect of warm water discharge from the diffuser on the round whitefish, lake whitefish and lake trout populations. It was hypothesized that populations of these species would be reduced as a result of the warm water discharge.

No reactor units were in full operation during the 1989 study period (three pump operation began on September 28, 1989, 35.1 Mgls). Therefore elevated water temperatures were not encountered (Appendix C). Preoperational and 1989 study results indicated however, that the inshore end of the diffuser was a favoured location for round whitefish and lake trout in the fall. The fall is the period prior to and during spawning for these species. Station operation may then have an effect on these species. Further study will be required to identify if these species continue to utilize this area during full station operation or shift their distribution.

Hypothesis No. 8 stated "The presence of a diffuser will lead to reductions in walleye, rainbow trout, brown trout and salmon populations". The 1989 gill netting results indicated these species were not present in great numbers in the vicinity of Darlington NGS. The walleye population was very low with only three walleye collected. Rainbow trout were present primarily in November when 28 fish were caught. The majority of these fish were collected west of the station (n = 13 fish), however, 11 rainbow trout were collected along the diffuser. Brown trout were collected throughout the 1989 study (n = 51 fish) with greatest abundance occurring in the fall spawning period. Twenty brown trout were collected at the two diffuser sampling sites during the possible October and November spawning period. Fourteen brown trout were collected at the two control sites in the same time period. Coho and chinook salmon were present only in minor numbers. Fewer than 10 fish of each of these species were collected.

When Darlington NGS becomes operational, the warm water discharge may influence the distribution of these species. Further studies are planned to monitor population distribution of these species relative to the discharge.

5. SUMMARY

1. Eighteen fish species were collected in the 1989 study. Twenty-five fish species were identified previously in the preoperational studies. No new species were identified in the 1989 study.

2. Alewife was the dominant species comprising 89.3% of the total catch (n = 6,722 fish). Alewife abundance peaked in July then declined sharply in succeeding sampling periods. Alewife abundance was greatest at the diffuser sites, with largest numbers occurring at the inshore sampling location.

3. Lake trout was the most prevalent salmonid species, with peak numbers occurring in early October. They were located primarily at the inshore end of the diffuser and at the east control site.

4. Round whitefish abundance was greatest in the fall with peak numbers present in late November. The majority of round whitefish were collected at the inshore diffuser sampling location.

5. The 1989 study catches were lower than the mean preoperational study catches. Alewife continued to be the dominant fish species with similar percent composition in both study phases. Lake trout per cent composition increased in the 1989 study while round whitefish and white sucker per cent composition declined.

6. The spatial distribution of fish species was generally similar during the two study phases. The majority of alewife and lake trout continued to be collected at the inshore diffuser site. Round whitefish distribution, similar at sites A and F in the preoperational study, was higher at the inshore end of the diffuser (site A) in the 1989 study.

7. The majority of fish (64.4%) and fish species (94.4%) were collected in the bottom net sets.

ACKNOWLEDGEMENTS

Mr. Jim Harcus conducted the field sampling program and prepared data for report presentation.

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APPENDIX A

DARLINGTON GILL NET DATA -- 1989

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET		
DATE	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM	TOTAL
MAY 5(S),4(B)															
SPECIES															
ALEWIFE	12	18	30	1	92	93	1	1	2		42	42	14	153	167
GIZZARD SHAD			0	0	0	0			0			0	0	0	0
RAINBOW SMELT			0			0			0			0	0	0	0
ROUND WHITEFISH			0			0		1	1			0	0	1	1
LAKE WHITEFISH			0			0			0			0	0	0	0
LAKE TROUT	1	2	3	1	1	2		3	3	4	1	5	6	7	13
BROWN TROUT		1	1			0			0		2	2	0	3	3
RAINBOW TROUT	1		1	2		2			0			0	3	0	3
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON			0			0			0			0	0	0	0
COHO SALMON	1		1			0			0			0	1	0	1
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER			0			0		3	3			0	0	3	3
REDHORSE SUCKER			0			0			0			0	0	0	0
LAKE CHUB		2	2		1	1			0			0	0	3	3
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH			0			0			0			0	0	0	0
WHITE BASS			0			0			0			0	0	0	0
YELLOW PERCH			0			0			0			0	0	0	0
WALLEYE			0			0			0			0	0	0	0
FRESHWATER DRUM			0			0			0			0	0	0	0
GAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD			0			0			0			0	0	0	0
CHANNEL CAT			0			0			0			0	0	0	0
CARP			0			0								0	0
TOTALS	15	23	38	4	94	98	1	8	9	4	45	49	24	170	194

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET	
DATE	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM
MAY 16(S),17(B)														
SPECIES														
ALEWIFE	70	141	211	23	354	377	121	256	377	124	202	326	338	953	1291
GIZZARD SHAD			0			0			0			0	0	0	0
RAINBOW SMELT			0	1		1			0			0	1	0	1
ROUND WHITEFISH			0		1	1			0			0	0	1	1
LAKE WHITEFISH			0			0			0			0	0	0	0
LAKE TROUT	6	2	8	3		3	2	2	4	8	4	12	19	8	27
BROWN TROUT		1	1	1		1	1		1			0	2	1	3
RAINBOW TROUT	1		1		2	2			0	1		1	2	2	4
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON			0			0			0			0	0	0	0
COHO SALMON			0			0			0			0	0	0	0
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER		1	1			0			0		4	4	0	5	5
REDHORSE SUCKER			0			0			0			0	0	0	0
LAKE CHUB			0		4	4			0			0	0	4	4
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH			0			0			0			0	0	0	0
WHITE BASS			0	1		1			0		1	1	1	1	2
YELLOW PERCH			0		1	1			0			0	0	1	1
WALLEYE			0			0			0			0	0	0	0
FRESHWATER DRUM			0			0			0			0	0	0	0
GAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD			0			0			0			0	0	0	0
CHANNEL CAT			0			0			0			0	0	0	0
CARP			0			0								0	0
TOTALS	77	145	222	29	362	391	124	258	382	133	211	344	363	976	1339

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET		
DATE	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM	TOTAL
JULY 7(S),5(B)															
SPECIES															
ALEWIFE	86	106	192	207	178	385	84	180	264	99	256	355	476	720	1196
GIZZARD SHAD			0			0			0			0	0	0	0
RAINBOW SMELT	1	2	3	1	3	4			0		3	3	2	8	10
ROUND WHITEFISH		1	1			0			0		4	4	0	5	5
LAKE WHITEFISH			0			0			0			0	0	0	0
LAKE TROUT		14	14		16	16		16	16		29	29	0	75	75
BROWN TROUT	1		1	1		1			0		1	1	2	1	3
RAINBOW TROUT			0			0			0			0	0	0	0
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON		1	1			0			0			0	0	1	1
COHO SALMON			0			0			0			0	0	0	0
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER		2	2		3	3	1	1	2		5	5	1	11	12
REDHORSE SUCKER			0			0			0			0	0	0	0
LAKE CHUB			0			0			0			0	0	0	0
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH			0			0			0			0	0	0	0
WHITE BASS			0			0			0			0	0	0	0
YELLOW PERCH			0			0			0			0	0	0	0
WALLEYE			0			0			0			0	0	0	0
FRESHWATER DRUM			0			0			0			0	0	0	0
BAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD			0			0			0			0	0	0	0
CHANNEL CAT			0			0			0			0	0	0	0
CARP			0			0								0	0
TOTALS	88	126	214	209	200	409	85	197	282	99	298	397	481	821	1302

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET		
JULY 19 (S/B)	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM	TOTAL
SPECIES															
ALEWIFE	111	132	243	641	555	1196	50	1040	1090	547	209	756	1349	1936	3285
GIZZARD SHAD			0			0			0			0	0	0	0
RAINBOW SMELT		6	6	0	4	4	1	3	4		1	1	1	14	15
ROUND WHITEFISH		4	4		3	3		1	1		3	3	0	11	11
LAKE WHITEFISH		1	1			0			0			0	0	1	1
LAKE TROUT			0			0		3	3		8	8	0	11	11
BROWN TROUT		1	1		1	1			0		6	6	0	8	8
RAINBOW TROUT			0			0			0			0	0	0	0
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON			0		1	1		1	1		1	1	0	3	3
COHO SALMON			0			0			0			0	0	0	0
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER			0		2	2		2	2		1	1	0	5	5
REDHORSE SUCKER			0			0			0			0	0	0	0
LAKE CHUB			0			0			0			0	0	0	0
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH			0			0			0			0	0	0	0
WHITE BASS			0			0			0			0	0	0	0
YELLOW PERCH			0			0			0			0	0	0	0
WALLEYE			0			0			0			0	0	0	0
FRESHWATER DRUM			0			0			0			0	0	0	0
GAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD			0			0			0			0	0	0	0
CHANNEL CAT			0			0			0			0	0	0	0
CARP			0			0								0	0
TOTALS	111	144	255	641	566	1207	51	1050	1101	547	229	776	1350	1989	3339

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET		
DATE	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM	TOTAL
OCT 11(S)/12(B)															
SPECIES															
ALEWIFE			0			0			0			0	0	0	0
GIZZARD SHAD			0			0			0			0	0	0	0
RAINBOW SMELT			0			0			0			0	0	0	0
ROUND WHITEFISH		6	6		7	7		8	8	0	0	0	0	21	21
LAKE WHITEFISH			0			0			0			0	0	0	0
LAKE TROUT	8	27	35	28	20	48	6	33	39	14	34	48	56	114	170
BROWN TROUT			0	3		3	3		3	3	1	4	9	1	10
RAINBOW TROUT	1		1			0			0			0	1	0	1
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON	1		1			0	1		1	1		1	3	0	3
COHO SALMON			0			0			0			0	0	0	0
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER		7	7		2	2			0		8	8	0	17	17
REDHORSE SUCKER			0			0			0			0	0	0	0
LAKE CHUB		1	1		2	2		1	1			0	0	4	4
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH			0			0			0			0	0	0	0
WHITE BASS			0			0			0			0	0	0	0
YELLOW PERCH			0			0			0			0	0	0	0
WALLEYE			0			0			0			0	0	0	0
FRESHWATER DRUM			0			0			0			0	0	0	0
GAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD			0			0			0			0	0	0	0
CHANNEL CAT			0			0			0			0	0	0	0
CARP			0			0			0			0	0	0	0
TOTALS	10	41	51	31	31	62	10	42	52	18	43	61	69	157	226

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET		
DATE	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM	TOTAL
OCT 27(S),28(B)															
SPECIES															
ALEWIFE	4		4		1	1	35	0	35	2	22	24	41	23	64
GIZZARD SHAD			0			0			0		1	1	0	1	1
RAINBOW SMELT			0			0			0			0	0	0	0
ROUND WHITEFISH		8	8		6	6		2	2		5	5	0	21	21
LAKE WHITEFISH			0			0			0			0	0	0	0
LAKE TROUT	1	10	11		8	8		17	17	3	10	13	4	45	49
BROWN TROUT		1	1	4	1	5	1		1		1	1	5	3	8
RAINBOW TROUT			0			0			0			0	0	0	0
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON			0			0			0	1		1	1	0	1
COHO SALMON			0			0			0			0	0	0	0
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER		2	2		3	3		2	2		7	7	0	14	14
REDHORSE SUCKER		0	0			0			0			0	0	0	0
LAKE CHUB		1	1		2	2			0		1	1	0	4	4
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH		1	1			0		4	4		4	4	0	9	9
WHITE BASS		1	1			0			0		1	1	0	2	2
YELLOW PERCH		0	0		1	1			0			0	0	1	1
WALLEYE		1	1		1	1			0			0	0	2	2
FRESHWATER DRUM			0			0			0			0	0	0	0
GAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD		9	9			0			0			0	0	9	9
CHANNEL CAT			0			0			0			0	0	0	0
CARP		1	1			0			0			0	0	1	1
TOTALS	5	35	40	4	23	27	36	25	61	6	52	58	51	135	186

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET		
DATE	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM	TOTAL
NOV 8(S)/7(B)															
SPECIES															
ALEWIFE		1	1			0			0			0	0	1	1
GIZZARD SHAD	1		1			0			0			0	1	0	1
RAINBOW SMELT			0			0			0			0	0	0	0
ROUND WHITEFISH		1	1		6	6		2	2		2	2	0	11	11
LAKE WHITEFISH			0			0			0			0	0	0	0
LAKE TROUT	3	10	13	2		2		6	6	1	1	2	6	17	23
BROWN TROUT	1		1	2		2	1		1	3		3	7	0	7
RAINBOW TROUT	4		4	3		3	3		3	4		4	14	0	14
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON			0			0			0	1		1	1	0	1
COHO SALMON			0			0			0			0	0	0	0
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER		1	1		1	1			0		4	4	0	6	6
REDHORSE SUCKER			0			0			0			0	0	0	0
LAKE CHUB		2	2		1	1			0			0	0	3	3
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH			0			0			0			0	0	0	0
WHITE BASS			0			0			0			0	0	0	0
YELLOW PERCH			0			0			0			0	0	0	0
WALLEYE		1	1			0			0			0	0	1	1
FRESHWATER DRUM			0			0			0			0	0	0	0
GAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD			0			0			0			0	0	0	0
CHANNEL CAT			0			0			0			0	0	0	0
CARP			0			0			0			0	0	0	0
TOTALS	9	16	25	7	8	15	4	8	12	9	7	16	29	39	68

LOCATION	F (WEST)			A (INSHORE DIFFUSER)			D (OFFSHORE DIFFUSER)			H (EAST)			CATCH/NET		
DATE	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	SURFACE	BOTTOM	TOTAL	T-SURF	BOTTOM	TOTAL
NOV 23(S,B)															
SPECIES															
ALEWIFE			0			0			0			0	0	0	0
GIZZARD SHAD			0			0			0			0	0	0	0
RAINBOW SMELT			0			0			0			0	0	0	0
ROUND WHITEFISH		8	8		18	18		2	2		7	7	0	35	35
LAKE WHITEFISH			0			0			0			0	0	0	0
LAKE TROUT		2	2			0			0			0	0	2	2
BROWN TROUT	1	1	2	2		2	3		3	2		2	8	1	9
RAINBOW TROUT	9		9	2		2	3		3	0		0	14	0	14
ATLANTIC SALMON			0			0			0			0	0	0	0
CHINOOK SALMON			0			0			0			0	0	0	0
COHO SALMON			0			0			0	1		1	1	0	1
PINK SALMON			0			0			0			0	0	0	0
WHITE SUCKER		1	1		2	2			0		1	1	0	4	4
REDHORSE SUCKER			0			0			0			0	0	0	0
LAKE CHUB			0		1	1			0			0	0	1	1
ROCK BASS			0			0			0			0	0	0	0
SMALLMOUTH BASS			0			0			0			0	0	0	0
LARGEMOUTH BASS			0			0			0			0	0	0	0
WHITE PERCH		2	2			0			0			0	0	2	2
WHITE BASS			0			0			0			0	0	0	0
YELLOW PERCH			0			0			0			0	0	0	0
WALLEYE			0			0			0			0	0	0	0
FRESHWATER DRUM			0			0			0			0	0	0	0
GAR PIKE			0			0			0			0	0	0	0
NORTHERN PIKE			0			0			0			0	0	0	0
BROWN BULLHEAD			0			0			0			0	0	0	0
CHANNEL CAT			0			0			0			0	0	0	0
CARP			0			0			0			0	0	0	0
TOTALS	10	14	24	4	21	25	6	2	8	3	8	11	23	45	68

Appendix B

DARLINGTON NGS FISH SPECIES COMPOSITION

COMMON NAME	SCIENTIFIC NAME
Longnose gar	*Lepisosteus osseus*
Alewife	*Alosa pseudoharengus*
Gizzard shad	*Dorosoma cepedianum*
Coho salmon	*Oncorhynchus kisutch*
Chinook salmon	*Oncorhynchus tshawytscha*
Rainbow trout	*Oncorhynchus mykiss*
Brown trout	*Salmo trutta*
Lake trout	*Salvelinus namaycush*
Lake whitefish	*Coregonus clupeaformis*
Round whitefish	*Prosopium cylindraceum*
Rainbow smelt	*Osmerus mordax*
Longnose sucker	*Catostomus catostomus*
White sucker	*Catostomus commersoni*
Redhorse suckers	*Moxostoma* sp.
Lake chub	*Couesius plumbeus*
Carp	*Cyprinus carpio*
Brown bullhead	*Ictalurus nebulosus*
White perch	*Morone americana*
White bass	*Morone chrysops*
Rock bass	*Ambloplites rupestris*
Smallmouth bass	*Micropterus dolomieui*
Yellow perch	*Perca flavescens*
Walleye	*Stizostedion vitreum vitreum*
Freshwater drum	*Aplodinotus grunniens*
Sculpin	*Cottus* sp.

APPENDIX C

WATER TEMPERATURES
DARLINGTON, 1989

SURFACE NETS

DATE			LOCATION F		LOCATION A		LOCATION D		LOCATION H	
			INSHORE	OFFSHORE	INSHORE	OFFSHORE	INSHORE	OFFSHORE	INSHORE	OFFSHORE
MAY 4/5	SET	SURFACE	6.5	6.5	7.3	7.3	6.6	6.0	7.7	7.0
		BOTTOM	5.5	5.0	5.8	5.7	5.3	5.1	5.8	5.5
	PULL	SURFACE	6.5	6.2	7.0	6.7	6.0	6.0	6.1	6.0
		BOTTOM	6.5	6.2	7.0	6.7	5.8	5.8	6.1	5.8
MAY 15/16	SET	SURFACE	8.7	8.3	9.0	9.0	8.3	8.2	9.0	8.8
		BOTTOM	8.3	8.0	8.5	8.5	7.5	7.3	8.5	7.9
	PULL	SURFACE	10.2	9.7	10.0	10.0	9.3	9.0	9.9	9.9
		BOTTOM	7.3	7.0	8.0	8.0	7.8	7.0	7.4	7.1
JULY 6/7	SET	SURFACE	20.5	20.5	20.8	20.9	20.9	20.5	20.0	19.2
		BOTTOM	11.5	9.0	14.5	13.1	9.9	8.7	9.0	8.0
	PULL	SURFACE	19.0	19.0	19.9	19.9	19.2	19.3	19.9	19.5
		BOTTOM	9.4	9.1	9.8	9.5	8.3	8.4	9.4	8.1
JULY 18/ 19	SET	SURFACE	17.0	17.3	16.3	18.1	16.0	16.3	16.5	17.4
		BOTTOM	13.3	12.0	12.7	11.8	10.8	10.4	11.1	8.8
	PULL	SURFACE	17.8	17.8	18.3	18.2	18.2	18.2	18.9	18.9
		BOTTOM	11.0	10.3	12.2	11.5	10.7	11.0	11.9	10.2
OCTOBER 10/11	SET	SURFACE	6.2	6.2	6.2	6.2	6.0	6.0	6.0	6.0
		BOTTOM	6.2	6.2	6.2	6.2	6.0	6.0	6.0	6.0
	PULL	SURFACE	6.2	6.2	6.0	6.2	6.0	6.0	6.0	6.0
		BOTTOM	6.2	6.2	6.0	6.2	6.0	6.0	6.0	6.0
OCTOBER 26/27	SET	SURFACE	11.5	11.5	12.0	12.0	11.5	11.5	11.9	12.0
		BOTTOM	11.2	11.5	11.5	11.5	11.5	11.5	11.4	11.5
	PULL	SURFACE	11.6	11.8	11.8	12.0	11.6	11.7	11.6	11.6
		BOTTOM	11.5	11.6	11.5	11.5	11.4	11.0	10.7	10.2
NOVEMBER 7/8	SET	SURFACE	6.7	6.7	6.8	6.7	6.5	6.5	6.3	6.3
		BOTTOM	6.7	6.7	6.8	6.7	6.5	6.5	6.3	6.3
	PULL	SURFACE	6.4	6.3	6.5	6.5	6.3	6.3	6.5	6.4
		BOTTOM	6.4	6.3	6.5	6.5	6.3	6.3	6.5	6.4
NOVEMBER 22/23	SET	SURFACE	4.0	4.0	3.5	3.8	4.1	4.1	4.0	4.2
		BOTTOM	4.0	4.0	3.0	3.8	4.1	4.1	3.8	4.0
	PULL	SURFACE	3.5	3.7	3.5	4.0	4.1	4.0	4.1	4.0
		BOTTOM	3.3	3.7	3.5	4.0	4.1	4.2	4.1	4.2

APPENDIX C

WATER TEMPERATURES
DARLINGTON, 1989

BOTTOM NETS

DATE			LOCATION F		LOCATION A		LOCATION D		LOCATION H	
			INSHORE	OFFSHORE	INSHORE	OFFSHORE	INSHORE	OFFSHORE	INSHORE	OFFSHORE
MAY 3/5	SET	SURFACE	5.5	5.5	6.5	5.5	5.5	5.0	6.5	6.0
		BOTTOM	5.5	5.5	6.5	6.0	5.5	5.5	6.5	6.0
	PULL	SURFACE	6.5	6.5	7.3	7.3	6.6	6.0	7.7	7.0
		BOTTOM	5.5	5.0	5.8	5.7	5.3	5.1	5.8	5.5
MAY 16/17	SET	SURFACE	10.2	9.7	10.0	10.0	-	-	9.9	9.9
		BOTTOM	7.3	7.0	8.0	8.0	-	-	7.4	7.1
	PULL	SURFACE	9.1	9.3	8.7	8.8	8.8	8.7	9.5	9.7
		BOTTOM	6.5	6.7	7.3	7.3	6.6	6.6	7.7	7.7
JULY 4/5	SET	SURFACE	13.5	15.5	14.9	12.3	14.8	16.4	15.3	16.7
		BOTTOM	8.2	7.6	8.0	8.0	7.1	6.8	7.7	7.0
	PULL	SURFACE	15.0	15.5	15.0	14.7	16.4	16.0	16.0	15.0
		BOTTOM	10.8	8.5	9.0	8.9	8.8	9.0	9.5	6.8
JULY 18/ 19	SET	SURFACE	17.0	17.3	16.3	18.1	16.0	16.3	16.5	17.4
		BOTTOM	13.3	12.0	12.7	11.8	10.8	10.4	11.1	8.8
	PULL	SURFACE	17.8	17.8	18.3	18.2	18.2	18.4	18.8	18.9
		BOTTOM	11.0	10.3	12.2	11.5	11.0	11.0	11.9	10.2
OCTOBER 11/12	SET	SURFACE	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
		BOTTOM	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	PULL	SURFACE	6.1	6.1	6.2	6.2	6.0	6.0	6.2	-
		BOTTOM	6.1	6.0	6.2	6.2	5.8	5.8	6.2	-
OCTOBER 25/26	SET	SURFACE	11.2	11.2	11.1	11.1	10.8	10.9	11.1	11.1
		BOTTOM	10.8	10.8	10.9	10.8	10.8	10.8	10.9	10.8
	PULL	SURFACE	11.5	11.5	12.0	12.0	11.5	11.5	11.9	12.0
		BOTTOM	11.2	11.5	11.5	11.5	11.5	11.5	11.4	11.5
NOVEMBER 6/7	SET	SURFACE	6.5	6.8	6.3	6.5	6.5	6.5	6.5	6.5
		BOTTOM	6.5	6.5	6.3	6.2	6.3	6.3	6.5	6.5
	PULL	SURFACE	6.7	6.7	6.8	6.7	6.3	6.3	6.5	6.5
		BOTTOM	6.7	6.7	6.8	6.7	6.3	6.3	6.5	6.5
NOVEMBER 22/23	SET	SURFACE	4.0	4.0	3.5	3.8	4.1	4.1	4.2	4.0
		BOTTOM	4.0	4.0	3.0	3.8	4.1	4.1	4.2	4.0
	PULL	SURFACE	3.5	3.7	3.5	4.0	4.1	4.0	4.1	4.0
		BOTTOM	3.3	3.7	3.5	4.0	4.1	4.2	4.1	4.2

Appendix D

Analysis of Variance Results (P>0.05)

Alewife Catch ANOVA - Randomized Block Design

Sampling Date X Sampling Location X Sampling Depth

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
DATE	1176788.250	7	168112.607	7.244	0.000
LOCATION	65455.875	3	21818.625	0.940	0.439
NET	38416.000	1	38416.000	1.655	0.212
DATE *LOCATION	233556.625	21	11121.744	0.479	0.950
DATE*NET	61831.000	7	8833.000	0.381	0.903
LOCATION*NET	56356.875	3	18785.625	0.809	0.503
ERROR	487357.125	21	23207.482		

Lake Trout Catch ANOVA - Randomized Block Design

Sampling Date X Sampling Location X Sampling Depth

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
DATE	2951.188	7	421.598	30.909	0.000
LOCATION	46.313	3	15.438	1.132	0.359
NET	564.063	1	564.063	41.354	0.000
DATE *LOCATION	274.938	21	13.092	0.960	0.537
DATE*NET	927.688	7	132.527	9.716	0.000
LOCATION*NET	77.813	3	25.938	1.902	0.160
ERROR	286.438	21	13.640		

Appendix D (cont'd)

Analysis of Variance Results (P>0.05)

Round Whitefish Catch ANOVA - Bottom Nets

Sampling Date and Sampling Location

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
DATE	242.875	7	34.696	4.051	0.006
LOCATION	44.125	3	14.708	1.717	0.194
ERROR	179.875	21	8.565		

Gill Net Depth of Catch ANOVA

Surface vs Bottom Nets

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
NET	58927.563	1	58927.563	3.608	0.063
DATE	1140180.188	7	162882.884	9.973	0.000
ERROR	898280.187	55	16332.367		

Appendix D (cont'd)

Analysis of Variance Results (P>0.05)

Alewife Catch ANOVA

Preoperational Years vs 1989

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
DATE	3850.031	1	3850.031	6.248	0.088
LOCATION	2273.834	3	757.945	1.230	0.434
ERROR	1848.614	3	616.205		

Lake Trout Catch ANOVA

Preoperational Years vs 1989

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
DATE	24.851	1	24.851	12.957	0.037
LOCATION	14.134	3	4.711	2.456	0.240
ERROR	5.754	3	1.918		

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